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Multifrequency EPR study of charge transfer in poly(3-alkylthiophenes)

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Abstract

The results of an investigation at different (10–140 GHz) wavebands EPR of magnetic, relaxation and dynamics parameters of mobile paramagnetic charge carriers (polarons) in low-dimensional solid-state poly(3-alkylthiophenes) semiconductors are discussed. At high registration frequency all components of the g-tensor of polarons are registered. Relaxation and diffusion rates of such paramagnetic impurities are determined by the method of steady-state saturation of spin packets.

Keywords: EPR; Organic semiconductor; Relaxation; Dynamics

1. Introduction

The magnetic and electronic properties of organic polymer semiconductors with an extended π-conjugated system have been widely studied in the last years [1] owing to their potential use as active materials in molecular electronics. Poly(3-alkylthiophene) (P3AT) seems a suitable model system for understanding the electronic and optical peculiarities of sulphur-based one-dimensional systems with non-degenerate ground states. The transport properties of P3AT are mainly governed by the presence of mobile polarons originating from the synthesis and the adsorption of oxygen from ambient atmosphere. The polaron possesses a spin $S = 1/2$, therefore P3AT is widely studied by the EPR method. At 3-cm waveband EPR the polaron in P3AT is characterized by a single line with peak-to-peak width of 0.6–0.8 mT and g-factor lying near the g-factor of the free electron [2]. However, at comparatively low-frequency ($\nu_e \leqslant 10$ GHz) EPR a low spectral resolution and a stronger spin exchange are revealed in the study of organic solids with paramagnetic impurities. Such factor limits significantly the self-descriptiveness and accuracy of the method and can lead to an ambiguous interpretation of the results obtained.

Earlier we have demonstrated [3,4] the advantages of 2-mm waveband EPR spectroscopy in the study of various polymer semiconductors, poly(3-octylthiophene) (P3OT) among them [5].

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